PATENT ABSTRACTS OF JAPAN

(11)Publication number : 10-256862

(43)Date of publication of application : 25.09.1998

(51)Int.Cl. H03H 9/145
H03H 3/08

(21)Application number : 09-060816

(22)Date of filing : 14.03.1997

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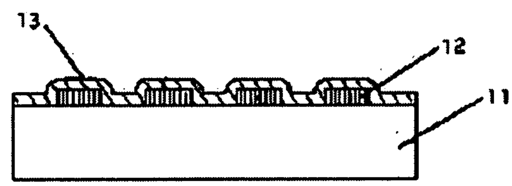
(54) SURFACE ACOUSTIC WAVE DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To improve the power resistance and to enhance the reliability.

SOLUTION: In the surface acoustic wave device where comb-line electrodes 12 are provided on a piezoelectric substrate 11 to stimulate or receive a surface acoustic wave, each comb-line electrode 12 is made of an aluminum metallic film whose crytallines are oriented in an azimuth and formed to cover a protection film 13. Or in order to enhance the orientation of an aluminum thin film, a background this film may be provided on the piezoelectric substrate.



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[Date of sending the examiner's decision of rejection]

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[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

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(19)日本国特許庁(JP)　(12)公開特許公報（A）　(11)特許出願公開番号

特開平１０－２５６８６２

(43)公開日　平成10年(1998)9月25日

(51)Int. Cl.⁶		識別記号	F I		
H03H	9/145		H03H	9/145	Z
	3/08			3/08	

審査請求　未請求　請求項の数６　ＯＬ　（全５頁）

(21)出願番号　特願平9-60816

(22)出願日　平成9年(1997)3月14日

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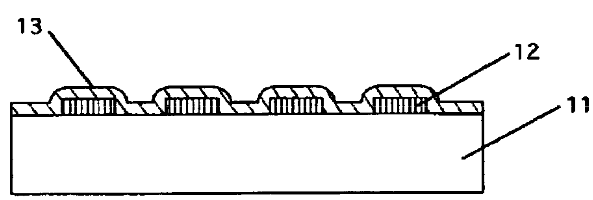
(54)【発明の名称】弾性表面波装置

(57)【要約】
【課題】　耐電力性の向上と信頼性の向上を図る。
【解決手段】　圧電性基板上に弾性表面波を励振または受信するための櫛形電極を備えた弾性表面波装置において、前記櫛形電極は、結晶が一定方位に配向されたアルミニウム金属膜で形成し、保護膜が覆うように形成されていることを特徴としている。また、前記アルミニウム薄膜の配向性を高めるために前記圧電基板上に下地薄膜を備えても良い。



【特許請求の範囲】

【請求項１】　圧電性基板上に弾性表面波を励振または受信するための櫛形電極を備えた弾性表面波装置において、
前記櫛形電極は、結晶が一定方位に配向されたアルミニウム金属膜で形成し、保護膜が覆うように形成されている、ことを特徴とする弾性表面波装置。

【請求項２】　圧電性基板上に弾性表面波を励振または受信するための櫛形電極を備えた弾性表面波装置において、
前記櫛形電極は、結晶が一定方位に配向されたアルミニウム金属膜からなり、前記圧電性基板上に前記アルミニウム金属膜の結晶の配向性を高めるような下地薄膜を備え、前記櫛形電極を保護膜が覆うように形成されている、ことを特徴とする弾性表面波装置。

【請求項３】　請求項１ないし請求項２のいずれか１項に記載した弾性表面波装置において、
前記櫛形電極は、アルミニウムに不純物が０．1ないし５wt%添加されたアルミニウム合金膜であり、その結晶が一定方位に配向している、ことを特徴とする弾性表面波装置。

【請求項４】　請求項１ないし請求項３のいずれか１項に記載した弾性表面波装置において、
前記保護膜は、絶縁性無機材料で構成されている、ことを特徴とする弾性表面波装置。

【請求項５】　請求項４に記載した弾性表面波装置において、
前記絶縁性無機材料は、二酸化シリコン膜（SiO_2）で構成されている、ことを特徴とする弾性表面波装置。

【請求項６】　請求項１ないし請求項３のいずれか１項に記載した弾性表面波装置において、
前記保護膜は、ポリイミド系樹脂材料で構成されている、ことを特徴とする弾性表面波装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、弾性表面波装置に関する。特に、電極膜の耐電力性、または大振幅の弾性表面波が定在波として存在する弾性表面波共振器、及び弾性表面波フィルタ、あるいは、電極幅が１μm以下の微細電極薄膜を有する弾性表面波装置に係り、優れた耐電力性、及び信頼性を有する弾性表面波装置に関する。

【０００２】

【従来の技術】弾性表面波（SAW）装置、特に弾性表面波フィルタは、普及が目覚ましい移動体通信、携帯電話等のＩＦフィルタに使われているが、近年、ＲＦ帯においても誘電体フィルタに替わって盛んに利用されるようになってきた。この理由としては、弾性表面波フィルタは、誘電体フィルタに較べて素子寸法が小さいこと、また同じ素子寸法で比較すると電気特性が優れていること等が挙げられる。しかし、弾性表面波装置を特に１GHz前後またはそれ以上の周波数帯、即ち、ＲＦ帯で利用する場合、弾性表面波の励振、受信をするために用いられる櫛形電極の電極幅、及び電極間隔が、それぞれおよそ１μm前後か、あるいはそれ以下と微細となり、また、電極膜厚もおよそ０．4μm以下の薄膜になるため、ＩＦ帯では問題とならなかった電極膜の耐電力性、即ち素子寿命が短いという問題があった。

【０００３】先ず、弾性表面波装置の耐電力性について説明する。弾性表面波装置の寿命を決めているのは、主に電極膜の耐電力性である。この弾性表面波装置の電極膜には、比重が小さいことと、電気抵抗が小さい等の理由からアルミニウム（Al）が使われている。さて、弾性表面波装置を動作状態にすると圧電基板上には弾性表面波が励起され、電極膜には周波数に比例した繰り返し応力が加わる。この繰り返し応力が電極膜中のアルミニウムのマイグレーションを生じさせる。このアルミニウムのマイグレーションにより、電極膜にはボイド（空乏）やヒロック（突起）といった欠陥が発生し、弾性表面波装置の特性を大きく劣化させることが知られている。この電極膜の劣化現象は、高周波になるほど、また、印加電力が大きいほど顕著に現れる。同時に、高周波になるほど、電極はより薄膜化、電極幅及びその間隔はより微細となる。これらの要因によって、高周波になるほど電極膜はマイグレーションによって欠陥が発生し易くなり、耐電力性が劣化し、素子寿命を短くしている。

【０００４】このアルミニウム電極膜の耐電力性を向上させるために、アルミニウムに微量の銅（Cu）を添加したアルミニウム－銅合金（Al－Cu）膜が J. I. Latham等により開示されている（Thin Solid Films、64、pp. 9－15、1979年）。このアルミニウムの合金化によって、電極膜のヒロックやボイドの発生を抑制し、弾性表面波装置の耐電力性を向上させた。また、高耐電力性を呈するようなアルミニウムへの添加金属としては 銅の他にもチタン（Ti）、パラジウム（Pd）、タングステン（W）等が提案されている。これらの添加金属は添加量が大きいほど膜抵抗率が大きくなるという欠点があるためにおよそ０．1から５wt%が望ましいとされている。

【０００５】一方、上記のアルミニウム膜またはアルミニウム合金膜の耐電力性を向上させるために、その結晶方位を一定方向に配向させる、またはその配向性を高くする、あるいは単結晶膜、エピタルキシャル膜にする等の弾性表面波装置が提案されている。それらは特開昭55－49014、特開平3－14309、特開平5－199062、特開平5－90268、特開平5－226337で開示されている。これらで開示されている電極膜は、その結晶性について、それぞれ異なった表記がなされているものの、結晶方位的に一定方向に配向していることが共通の特徴である。一般に圧電基板上に電極膜を形成する場合、蒸着法またはスパッタ法を用いるが、得られる電極膜は通常、複数の結晶面を有する多結晶膜である。この多結晶電極膜に対し

て、上述の結晶方位が一定方位に配向している電極膜は、およそ百倍ないし数百倍の耐電力性を呈することが知られている。

【０００６】

【発明が解決しようとする課題】上記のように結晶方位が一定方向に配向している電極膜は、優れた耐電力性を呈するが、その耐電力性を評価する耐電力試験においては、以下のような特有の現象が現れる。図５に、多結晶アルミニウム電極膜と、結晶方位が一定方位に配向しているアルミニウム電極膜のそれぞれ５試料の耐電力試験結果を示す。試験試料の弾性表面波装置は、図６に示す耐電力試験回路で試験を実施した。試験試料は、オーブンに入れ 80℃の周囲温度で、電力は1Wを印加した。また、試験中の弾性表面波装置の電気特性はネットワークアナライザによって随時測定できるようにした。

【０００７】図５の結果より、多結晶膜では、試験開始後、弾性表面波装置の挿入損失がおよそ１dB程度まで増加している。そこで、電極膜表面の電子顕微鏡観察を行ったところ、電極膜にはボイドとヒロックが発生していることがわかった。この電極膜に発生した欠陥が電極膜の比抵抗を大きくし弾性表面波装置の挿入損失を大きくしていることがわかった。そして、更に試験を続けることで、成長したヒロックが隣の電極に接触することで電極間はショートし、×印の点で電極が破壊する。

【０００８】一方、結晶方位が一定方向に配向している電極膜の場合は、試験途中の挿入損失の増加が極めて小さい。この電極膜表面を電子顕微鏡観察したところ、試験中の電極膜には多結晶膜にみられたような大きなヒロックがなく、非常に小さなボイドだけが観察された。従って電極膜の欠陥が非常に少ないために、挿入損失の変化も小さいことがわかった。しかし、試験を継続して行くと、ある時間で突然、電極破壊（×印）が発生する。わずかなボイドは発生しているものの電極破壊の原因であるヒロックは発生していないことから、この電極破壊の原因については不明であった。また、５つの試料の寿命は多結晶膜に較べて100倍以上と非常に長いものの、そのばらつきが大きく、電極破壊が予期せぬ時間で起きるという課題があった。

【０００９】そこで、本発明は、電極材料に結晶方位が一定方位に配向しているアルミニウム薄膜、ないしアルミニウム合金薄膜を用いて、電極薄膜の耐電力性が向上され、かつ信頼性が高い弾性表面波装置を提供することを目的とする。

【００１０】

【課題を解決するための手段】本発明は、上記課題を解決するために以下の構成を備えている。

（構成１）　圧電性基板上に弾性表面波を励振または受信するための櫛形電極を備えた弾性表面波装置において、前記櫛形電極は、結晶が一定方位に配向されたアルミニウム金属膜で形成し、保護膜が覆うように形成されている弾性表面波装置。

【００１１】（構成２）　圧電性基板上に弾性表面波を励振または受信するための櫛形電極を備えた弾性表面波装置において、前記櫛形電極は、結晶が一定方位に配向されたアルミニウム金属膜からなり、前記圧電性基板上に前記アルミニウム金属膜の結晶の配向性を高めるような下地薄膜を備え、前記櫛形電極を保護膜が覆うように形成されている弾性表面波装置。

【００１２】（構成３）　構成１ないし構成２のいずれか１つに記載した弾性表面波装置において、前記櫛形電極は、アルミニウムに不純物が 0．1ないし５wt%添加されたアルミニウム合金膜であり、その結晶が一定方位に配向している弾性表面波装置。

【００１３】（構成４）　構成１ないし構成３のいずれか１つに記載した弾性表面波装置において、前記保護膜は、絶縁性無機材料で構成されている弾性表面波装置。

【００１４】（構成５）　構成４に記載した弾性表面波装置において、前記絶縁性無機材料は、二酸化シリコン膜（SiO2）で構成されている弾性表面波装置。

【００１５】（構成６）　構成１ないし構成３のいずれか１つに記載した弾性表面波装置において、前記保護膜は、ポリイミド系樹脂材料で構成されている弾性表面波装置。

【００１６】（作用効果）上記課題に記したように、突然発生する電極破壊の原因について調べた結果、以下のことを明らかにした。即ち、結晶方位が一定方位に配向している電極膜では、徐々に成長するボイドやヒロックとは異なるウイスカが発生することがわかった。このウイスカは、ボイドのように大きくはないが、非常に細くて長いという特徴がある。電極膜にウイスカが発生したとしても、大きさが非常に小さく、例えば１個のウイスカが発生したとしても挿入損失の変化にはほとんど影響しない。しかし、そのたった１個のウイスカでも、成長することで電極間をショートさせるにまで至るのである。このウイスカの発生原因については明らかではないが、結晶性が優れているとしても電極膜すべての結晶方位が一定方位に配向しているのではなく、多結晶状態もわずかながら存在しているために、そのような結晶性の不整合がある場所でウイスカが発生しているのではないかと考えられる。しかし、多結晶膜でみられるヒロックとは異なり、ウイスカという形で発生する理由については不明である。

【００１７】上述のように本願発明では、櫛形電極部全体に形成した保護膜によって、結晶方位が一定方位に配向している電極膜における破壊原因であるウイスカの発生を抑制しているものと考えられる。

【００１８】

【発明の実施の形態】以下、本発明の実施例をもとに説明する。本実施例の弾性表面波装置は、中心周波数 947．5MHzの携帯電話機RF段間フィルタ用に設計した弾性

表面波フィルタである。圧電基板としてニオブ酸リチウム（LiNbO3）ウエハー11を用い、電極膜を通常のフォトリソグラフィ技術で電極加工を行った。

【0019】図1に、本発明の弾性表面波装置の断面図を示す。圧電基板として、ニオブ酸リチウム（LiNbO3）ウエハー11を用いた。この圧電基板上に、厚さ約0.16μmの結晶方位が一定方向に配向されたアルミニウム薄膜12を成膜、そして電極加工をした。図2に、本発明の他の弾性表面波装置の断面図を示す。この実施例では、結晶方位的に一定方向に配向しやすくするために、下地にチタン薄膜24を形成した後、アルミニウム薄膜22を成膜、そして電極加工をした。それぞれのアルミニウム膜をX線回折法で測定して、結晶方位的に一定方向に配向したアルミニウム膜であることを確認した。電極幅は、およそ1μmとした。試験試料は、保護膜を成膜したものと、しないものの2種類にわけて作製し、組立工程を経て、最終的には3.8mm×3.8mmのセラミック積層パッケージに設置して試験試料とした。なお、保護膜が導電性材料であると電極間が短絡状態となり弾性表面波の励振または受信に支障を来すため、絶縁性無機材料である二酸化シリコン膜（SiO2）を用いた。

【0020】耐電力試験は、図6に示す測定回路で行った。温度80℃のオーブン内に試験試料である弾性表面波フィルタを入れ、入力（投入）電力1Wを印加した。この弾性表面波フィルタにはネットワークアナライザが接続されており、試験中のフィルタの電気特性が測定できるようになっている。なお、試験試料の寿命は、フィルタの挿入損失が0.5dB増加したときの時間、若しくは電極間がショートして素子破壊に至る時間とした。

【0021】上記のように作製した保護膜がある5個の試料の耐電力試験結果を図3、及び保護膜のない5個の試料の耐電力試験結果を図4に示す。この図から明らかなように保護膜がある試料では、寿命のばらつきも小さく、寿命もおよそ2ないし3倍程度延びている。即ち、本願発明の結晶方位的に一定方向の電極膜上に形成された保護膜が、耐電力性を向上させ、寿命のばらつきも小さくすることが明らかとなった。

【0022】次にポリイミド樹脂膜を保護膜として用いた場合についても上記と同様の実験を行った。その結果、寿命のばらつきには効果がなかったものの、耐電力性はおよそ2倍程度の改善がみられた。二酸化シリコン膜ほどの改善はみられないものの、保護膜がない場合に較べれば改善があることがわかった。

【0023】なお、下地薄膜には チタンを用いたが、この他に、銅（Cu）、タングステン（W）、クロム（Cr）、ニッケル（Ni）等の金属薄膜が知られているが、それら下地膜上に形成されたアルミニウム膜が結晶方位的に一定方位に配向してさえいれば、下地膜の材質については問わない。また、従来技術で述べたように、アルミニウムに0.1ないし5wt%の微量の不純物を添加したアルミニウム合金膜でも、その結晶方位が一定方位に配向していれば同様の効果が得られた。

【0024】ところで、圧電基板に、LiTaO3基板、LiTaO3基板、Li2B4O7基板を用いて、それぞれの基板上に形成した配向性の高いアルミニウム膜上に、保護膜を備えた場合も実験したが、同様の効果が得られ、本願発明が圧電基板の種類に依存しないことを確認した。

【0025】

【発明の効果】以上説明したように本願発明によると、耐電力性に優れ、しかも信頼性の高い弾性表面波装置が得られた。

【図面の簡単な説明】

【図1】本願発明の構成による弾性表面波装置断面図である。

【図2】本願発明の構成による弾性表面波装置断面図である。

【図3】本願発明による弾性表面波装置の耐電力試験中の挿入損失の時間変化を示す図である。

【図4】従来の弾性表面波装置の耐電力試験中の挿入損失の時間変化を示す図である。

【図5】多結晶アルミニウム電極膜と、結晶方位が一定方向に配向しているアルミニウム電極膜の耐電力試験結果を示す図である。

【図6】弾性表面波装置の耐電力試験（寿命加速試験）の測定回路を示す図である。

【符号の説明】

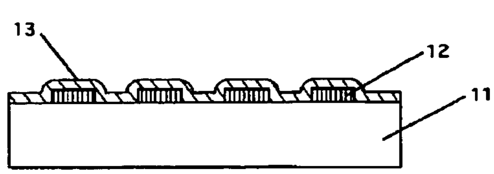
11、21　圧電基板

12、22　結晶方位が一定方向に配向した電極

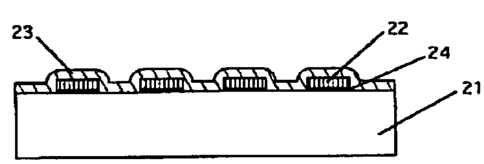
13、23　保護膜

24　下地薄膜

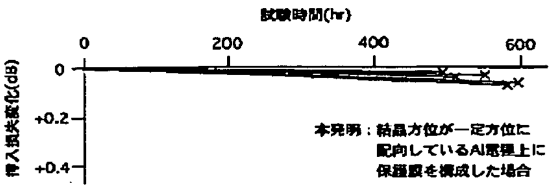
【図1】



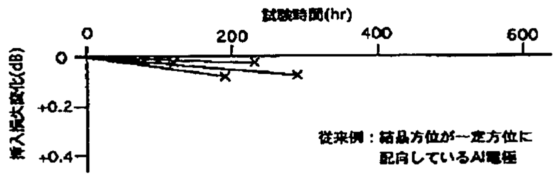
【図2】



【図３】


試験時間(hr)
0
200
400
600
挿入損失変化(dB)
0
+0.2
+0.4
本発明：結晶方位が一定方位に
配向しているAl電極上に
保護膜を構成した場合

【図４】


試験時間(hr)
0
200
400
600
挿入損失変化(dB)
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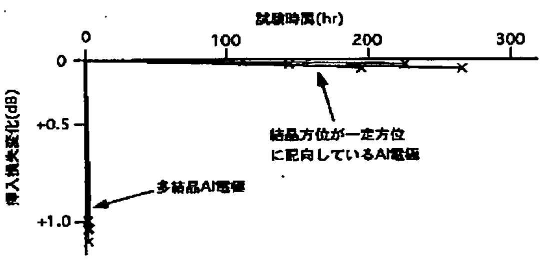
+0.2
+0.4
従来例：結晶方位が一定方位に
配向しているAl電極

【図５】


試験時間(hr)
0
100
200
300
挿入損失変化(dB)
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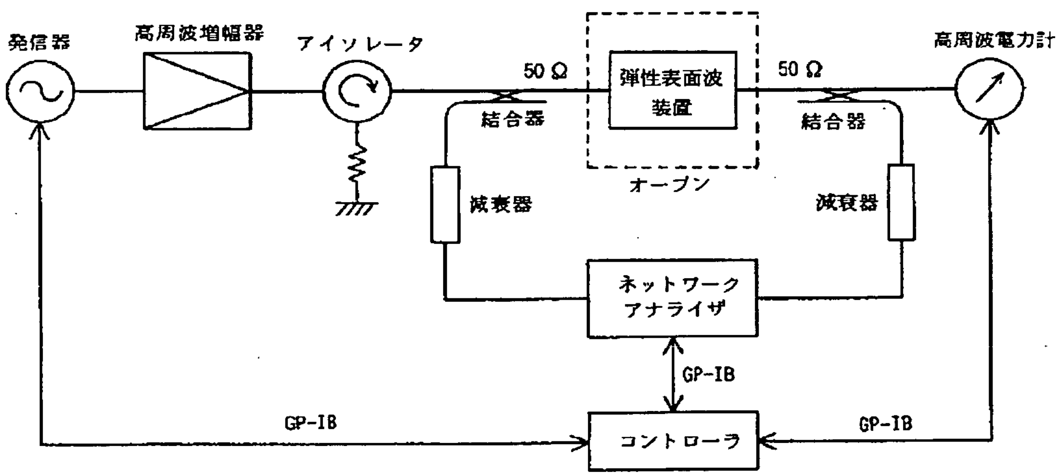
+0.5
+1.0
結晶方位が一定方位
に配向しているAl電極
多結晶Al電極

【図６】


発信器
高周波増幅器
アイソレータ
50Ω
弾性表面波
装置
50Ω
高周波電力計
結合器
結合器
オーブン
減衰器
減衰器
ネットワーク
アナライザ
GP-IB
GP-IB
コントローラ
GP-IB

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 10-256862

(43)Date of publication of application : 25.09.1998

(51)Int.Cl. H03H 9/145

H03H 3/08

(21)Application number : 09-060816

(22)Date of filing : 14.03.1997

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NAKANO MASAHIRO
SATO KATSUO

(54) SURFACE ACOUSTIC WAVE DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To improve the power resistance and to enhance the reliability.

SOLUTION: In the surface acoustic wave device where comb-line electrodes 12 are provided on a piezoelectric substrate 11 to stimulate or receive a surface acoustic wave, each comb-line electrode 12 is made of an aluminum metallic film whose crytallines are oriented in an azimuth and formed to cover a protection film 13. Or in order to enhance the orientation of an aluminum thin film, a background this film may be provided on the piezoelectric substrate.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

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CLAIMS

[Claim(s)]

[Claim 1] Said Kushigata electrode is surface acoustic wave equipment

characterized by what it forms by the aluminum metal membrane by which orientation of the crystal was carried out to fixed bearing in the surface acoustic wave equipment equipped with the Kushigata electrode for exciting or receiving a surface acoustic wave on the piezoelectric substrate, and is formed so that a protective coat may cover.

[Claim 2] Said Kushigata electrode is surface acoustic wave equipment characterized by what it consists of an aluminum metal membrane by which orientation of the crystal was carried out to fixed bearing in the surface acoustic wave equipment equipped with the Kushigata electrode for exciting or receiving a surface acoustic wave on the piezoelectric substrate, and has a substrate thin film which raises the stacking tendency of the crystal of said aluminum metal membrane on said piezoelectric substrate, and is formed so that a protective coat may cover said Kushigata electrode.

[Claim 3] the surface acoustic wave equipment indicated in any 1 term of claim 1 thru/or claim 2 -- setting -- said Kushigata electrode -- aluminum -- impurity 0.1 thru/or 5wt(s)% -- surface acoustic wave equipment which is the added aluminum alloy film and is characterized by what the crystal is doing to fixed bearing for orientation.

[Claim 4] It is surface acoustic wave equipment characterized by what said protective coat consists of insulating inorganic materials for in the surface acoustic wave equipment indicated in any 1 term of claim 1 thru/or claim 3.

[Claim 5] It is surface acoustic wave equipment characterized by what said insulating inorganic material consists of diacid-ized silicon film (SiO_2) for in the surface acoustic wave equipment indicated to claim 4.

[Claim 6] It is surface acoustic wave equipment characterized by what said protective coat consists of polyimide system resin ingredients for in the surface acoustic wave equipment indicated in any 1 term of claim 1 thru/or claim 3.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to surface acoustic wave equipment. Especially, the power-proof nature of an electrode layer or the surface acoustic wave resonator with which the surface acoustic wave of the large amplitude exists as a standing wave and a surface acoustic wave filter, or electrode width of face is applied to the surface acoustic wave equipment which has a detailed electrode thin film 1 micrometer or less, and it is related with the surface acoustic wave equipment which has the outstanding power-proof nature and dependability.

[0002]

[Description of the Prior Art] Although spread is used for IF filters, such as remarkable mobile communications and a cellular phone, surface acoustic wave (SAW) equipment, especially a surface acoustic wave filter are replaced with a dielectric filter also in RF band, and have come to be used briskly in recent years. If a surface acoustic wave filter is compared with that a component dimension is small and the same component dimension compared with a dielectric filter, the fact that the electrical property is excellent etc. will be cited as this reason. Especially surface acoustic wave equipment However, the frequency band beyond 1GHz order or it, Namely, the electrode width of face of the Kushigata

electrode used in order to carry out excitation of a surface acoustic wave, and reception when using with RF band, and an electrode spacing -- being as detailed as less than [about 1 micrometer order or it] respectively -- becoming -- moreover, electrode layer thickness -- about -- Since it became a thin film 0.4 micrometers or less, with IF band, there was a problem of being short, the power-proof nature, i.e., the component life, of the electrode layer used as a problem.

[0003] First, the power-proof nature of surface acoustic wave equipment is explained. The power-proof nature of an electrode layer has mainly determined the life of surface acoustic wave equipment. Aluminum (aluminum) is used for the electrode layer of this surface acoustic wave equipment from that specific gravity is small and the reasons nil why electric resistance is small etc. Now, if surface acoustic wave equipment is made into operating state, a surface acoustic wave will be excited on a piezo-electric substrate, and the repeated stress proportional to a frequency joins an electrode layer. This repeated stress produces the migration of the aluminum in an electrode layer. Defects, such as a void (depletion) and a hillock (projection), occurring in an electrode layer, and degrading the property of surface acoustic wave equipment greatly by the migration of this aluminum, is known. The degradation phenomenon of this electrode layer appears so notably that impression power is so large that it becomes a RF. Simultaneously, an electrode becomes more detailed [thin-film-izing electrode width of face, and its spacing] more, so that it becomes a RF. By migration, it becomes easy to generate a defect, power-proof nature deteriorates, and the electrode layer shortens the component life, so that it becomes a RF according to these factors.

[0004] In order to raise the power-proof nature of this aluminum electrode layer, the aluminum-copper alloy (aluminum-Cu) film which added the copper (Cu) of a minute amount to aluminum It is indicated by J.I.Latham etc. (Thin Solid Films, 64, pp.9 1979 [-15 or]). By alloying of this aluminum, the hillock of an electrode layer and generating of a void were controlled and the power-proof nature of surface acoustic wave equipment was raised. Moreover, it is an addition metal to

aluminum which presents power-proof [quantity] nature. Titanium (Ti), palladium (Pd), a tungsten (W), etc. are proposed other than copper. since these addition metals have the fault that the rate of membrane resistance becomes large so that an addition is large -- about -- It is supposed that 0.1 to 5wt(s)% is desirable.

[0005] On the other hand, in order to raise the power-proof nature of the above-mentioned aluminum film or the aluminum alloy film, or it makes the orientation of the crystal orientation carry out in the fixed direction, surface acoustic wave equipment, such as making the stacking tendency high or using it as the single crystal film and the EPITARUKISHARU film, is proposed. They are indicated by JP,55-49014,A, JP,3-14309,A, JP,5-199062,A, JP,5-90268,A, and JP,5-226337,A. The electrode layer currently indicated by these is the description with common carrying out orientation in the fixed direction in crystal orientation, although a notation different, respectively is made about the crystallinity. Although vacuum deposition or a spatter is used when forming an electrode layer on a piezo-electric substrate generally, the electrode layer obtained is usually polycrystal film which has two or more crystal faces. It is known to this polycrystal electrode layer that the electrode layer in which above-mentioned crystal orientation is carrying out orientation to fixed bearing will present about 100 times thru/or hundreds times as many power-proof nature as this.

[0006]

[Problem(s) to be Solved by the Invention] Although the electrode layer in which crystal orientation is carrying out orientation in the fixed direction as mentioned above presents the outstanding power-proof nature, the following characteristic phenomena appear in the power-proof trial which evaluates the power-proof nature. the aluminum electrode layer in which crystal orientation is carrying out orientation to drawing 5 in the fixed bearing with the polycrystal aluminum electrode layer -- the power-proof test result of five samples is shown, respectively. The surface acoustic wave equipment of a test sample examined in the power-proof test circuit shown in drawing 6 . A test sample is paid to oven. It is 80 degrees C in ambient temperature, and power impressed 1W. Moreover, it

enabled it to measure the electrical property of the surface acoustic wave equipment under trial at any time with a network analyzer.

[0007] By the polycrystal film, the insertion loss of surface acoustic wave equipment is increasing from the result of drawing 5 to about 1dB after test initiation. Then, when electron microscope observation on the front face of an electrode layer was performed, it turned out that the void and the hillock have occurred at the electrode layer. It turned out that the defect generated in this electrode layer enlarges specific resistance of an electrode layer, and enlarges the insertion loss of surface acoustic wave equipment. And inter-electrode short-circuits because the grown-up hillock contacts the next electrode by continuing a trial further, and an electrode breaks in respect of x mark.

[0008] In the case of the electrode layer in which crystal orientation is carrying out orientation in the fixed direction on the other hand, the increment in the insertion loss in the middle of a trial is very small. When electron microscope observation of this electrode layer front face was carried out, there is no big hillock which was seen by the polycrystal film in the electrode layer under trial, and only the very small void was observed. Therefore, since there were very few defects of an electrode layer, it turned out that change of an insertion loss is also small. However, if a trial is continued and it goes, electrode destruction (x mark) will occur suddenly in a certain time amount. Although few voids were generated, since it had not generated, the hillock which caused electrode destruction was unknown about the cause of this electrode destruction. Moreover, although the life of five samples was dramatically as long as 100 or more times compared with the polycrystal film, it had the technical problem that the dispersion was large and it occurred by the time amount which electrode destruction does not expect.

[0009] Then, this invention aims to an electrode material to let crystal orientation for the power-proof nature of an electrode thin film to improve, and provide fixed bearing with reliable surface acoustic wave equipment using the aluminum thin film which is carrying out orientation thru/or an aluminum alloy thin film.

[0010]

[Means for Solving the Problem] This invention is equipped with the following configurations in order to solve the above-mentioned technical problem.
(Configuration 1) Said Kushigata electrode is surface acoustic wave equipment which forms by the aluminum metal membrane by which orientation of the crystal was carried out to fixed bearing in the surface acoustic wave equipment equipped with the Kushigata electrode for exciting or receiving a surface acoustic wave on the piezoelectric substrate, and is formed so that a protective coat may cover.
[0011] (Configuration 2) Said Kushigata electrode is surface acoustic wave equipment currently formed so that it may consist of an aluminum metal membrane by which orientation of the crystal was carried out to fixed bearing in the surface acoustic wave equipment equipped with the Kushigata electrode for exciting or receiving a surface acoustic wave on the piezoelectric substrate, it may have a substrate thin film which raises the stacking tendency of the crystal of said aluminum metal membrane on said piezoelectric substrate and a protective coat may cover said Kushigata electrode.
[0012] (Configuration 3) the surface acoustic wave equipment indicated to any one of a configuration 1 thru/or the configurations 2 -- setting -- said Kushigata electrode -- aluminum -- impurity 0.1 thru/or 5wt(s)% -- surface acoustic wave equipment in which is the added aluminum alloy film and the crystal is carrying out orientation to fixed bearing.
[0013] (Configuration 4) It is surface acoustic wave equipment with which said protective coat consists of insulating inorganic materials in the surface acoustic wave equipment indicated to any one of a configuration 1 thru/or the configurations 3.
[0014] (Configuration 5) It is surface acoustic wave equipment with which said insulating inorganic material consists of diacid-ized silicon film (SiO_2) in the surface acoustic wave equipment indicated in the configuration 4.
[0015] (Configuration 6) It is surface acoustic wave equipment with which said protective coat consists of polyimide system resin ingredients in the surface

acoustic wave equipment indicated to any one of a configuration 1 thru/or the configurations 3.

[0016] (The operation effectiveness) The following things were clarified as a result of investigating about the cause of the electrode destruction which carries out the heterogenesis, as described in the above-mentioned technical problem. That is, in the electrode layer in which crystal orientation is carrying out orientation to fixed bearing, it turned out that a different whisker from the void which grows gradually, or a hillock occurs. Although this whisker is not large like a void, there is the description that it is very thin and long. Even if a whisker occurs in an electrode layer, even if magnitude is dramatically small, for example, one whisker occurs, change of an insertion loss is hardly influenced. however, at least the only one whisker short-circuits inter-electrode by growing up -- even making -- it results. Although it is not clear about the cause of generating of this whisker, though crystallinity is excellent, since the crystal orientation of all electrode layers has not carried out orientation to fixed bearing and the polycrystal condition also exists slightly, it is thought that the whisker will have occurred in the location with such crystalline mismatching. However, about the reason which is generated in the form of a whisker unlike the hillock seen by the polycrystal film, it is unknown.

[0017] By the invention in this application, crystal orientation is considered to have controlled generating of the whisker which is the cause of destructive in the electrode layer which is carrying out orientation to fixed bearing as mentioned above by the protective coat formed in the whole Kushigata polar zone.

[0018]

[Embodiment of the Invention] Hereafter, it explains based on the example of this invention. The surface acoustic wave equipment of this example is center frequency. It is the surface acoustic wave filter designed in 947.5MHz portable telephone RF interstage filters. The usual photolithography technique performed electrode processing for the electrode layer, using the lithium-niobate ($LiNbO3$) wafer 11 as a piezo-electric substrate.

[0019] The sectional view of the surface acoustic wave equipment of this invention is shown in drawing 1 . As a piezo-electric substrate, the lithium-niobate ($LiNbO_3$) wafer 11 was used. On this piezo-electric substrate, it is thickness abbreviation. 0.16-micrometer crystal orientation carried out membrane formation and electrode processing for the aluminum thin film 12 by which orientation was carried out in the fixed direction. The sectional view of other surface acoustic wave equipments of this invention is shown in drawing 2 . In this example, in order to make orientation easy to carry out in the fixed direction in crystal orientation, after forming the titanium thin film 24 in a substrate, membrane formation and electrode processing were carried out for the aluminum thin film 22. Each aluminum film was measured with the X-ray diffraction method, and it checked that it was the aluminum film which carried out orientation in the fixed direction in crystal orientation. Electrode width of face was set to about 1 micrometer. It bends with what formed the protective coat, and it divides into two kinds of things, produces, it passes like an erector, and a test sample is in the last target. It installed in the ceramic stacked package of 3.8mmx 3.8mm, and considered as the test sample. In addition, in order for inter-electrode to be in a short circuit condition for a protective coat to be a conductive ingredient and to cause trouble to excitation or reception of a surface acoustic wave, the diacid-ized silicon film (SiO_2) which is an insulating inorganic material was used.
[0020] The power-proof trial was performed in the measuring circuit shown in drawing 6 . Temperature In 80-degree C oven, the surface acoustic wave filter which is a test sample was put in, and input (charge) power 1W were impressed. The network analyzer is connected to this surface acoustic wave filter, and the electrical property of the filter under trial can be measured now. In addition, the insertion loss of a filter the life of a test sample It considered as the time amount when increasing 0.5dB, or the time amount which inter-electrode short-circuits and results in component destruction.
[0021] The power-proof test result of five samples which do not have drawing 3 and a protective coat in the power-proof test result of five samples with the

protective coat produced as mentioned above is shown in drawing 4 . By the sample which has a protective coat so that clearly from this drawing, dispersion in a life is also small, a life does not have about 2, either, and it has extended by about 3 times. That is, it became clear that the protective coat formed on the electrode layer of the fixed direction like crystal orientation of the invention in this application raises power-proof nature, and also makes dispersion in a life small.

[0022] Next, the experiment same also about the case where the polyimide resin film is used as a protective coat as the above was conducted. Consequently, although there was no effectiveness in dispersion in a life, as for power-proof nature, the improvement of about about 2 times was found. Although the improvement like the diacid-ized silicon film was not found, when there was no protective coat and having been compared, it turned out that there is an improvement.

[0023] In addition, it is in a substrate thin film. Although titanium was used, in addition although metal thin films, such as copper (Cu), a tungsten (W), chromium (Cr), and nickel (nickel), are known, if the aluminum film formed on these substrates film carries out orientation to fixed bearing and is clear and is in it in crystal orientation, it will not ask about the construction material of the substrate film. Moreover, as the conventional technique described, the same effectiveness was acquired when the crystal orientation was carrying out orientation also of the aluminum alloy film which added the impurity of a minute amount (0.1 thru/or 5wt(s)%) to aluminum to fixed bearing.

[0024] By the way, although it experimented on the piezo-electric substrate also when it had a protective coat on the high aluminum film of the stacking tendency which used LiTaO3 substrate, LiTaO3 substrate, and 4OLi2B7 substrate, and was formed on each substrate, the same effectiveness was acquired and it checked that the invention in this application was not dependent on the class of piezo-electric substrate.

[0025]

[Effect of the Invention] As explained above, according to the invention in this

application, it excelled in power-proof nature and, moreover, reliable surface acoustic wave equipment was obtained.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is a surface acoustic wave equipment sectional view by the configuration of the invention in this application.

[Drawing 2] It is a surface acoustic wave equipment sectional view by the configuration of the invention in this application.

[Drawing 3] It is drawing showing time amount change of the insertion loss under power-proof trial of the surface acoustic wave equipment by the invention in this application.

[Drawing 4] It is drawing showing time amount change of the insertion loss under power-proof trial of conventional surface acoustic wave equipment.

[Drawing 5] It is drawing showing the power-proof test result of a polycrystal aluminum electrode layer and the aluminum electrode layer in which crystal orientation is carrying out orientation in the fixed direction.

[Drawing 6] It is drawing showing the measuring circuit of a power-proof trial (life

accelerated test) of surface acoustic wave equipment.

[Description of Notations]

11 21 Piezo-electric substrate

12 22 Electrode in which crystal orientation carried out orientation in the fixed direction

13 23 Protective coat

24 Substrate Thin Film

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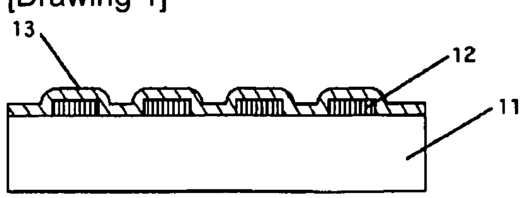
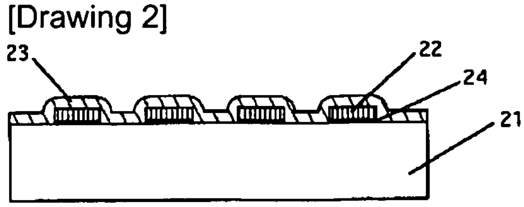
DRAWINGS

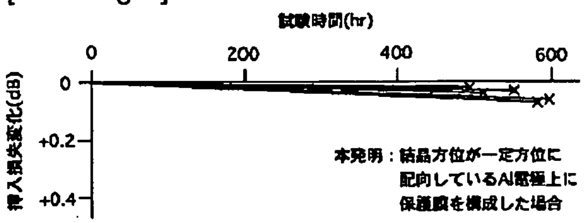
[Drawing 1]



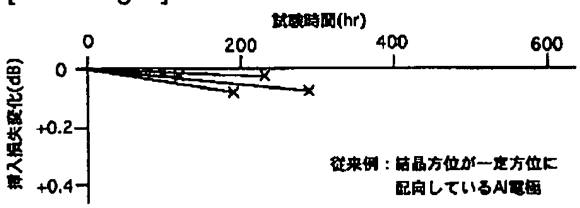
[Drawing 2]



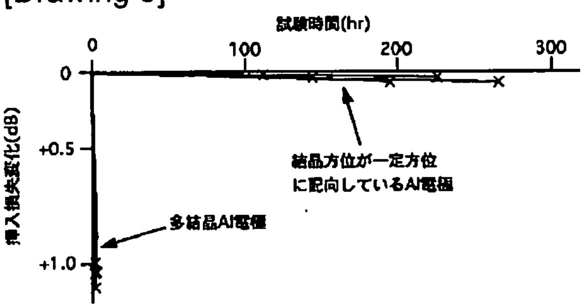
[Drawing 3]



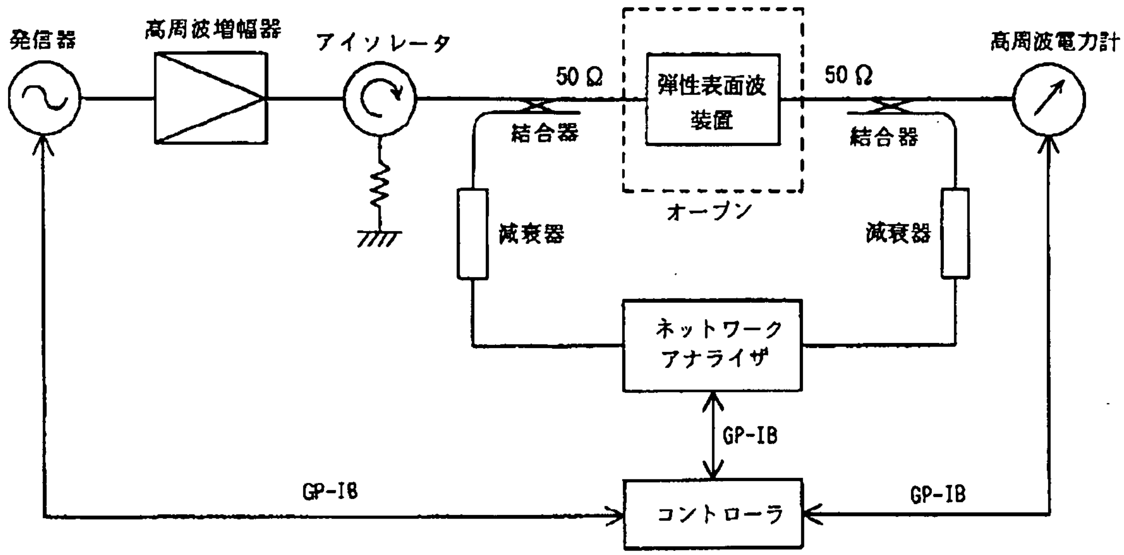
[Drawing 4]



[Drawing 5]



[Drawing 6]



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